The impact of geophysical turbulence on three-dimensional plankton distribution patterns

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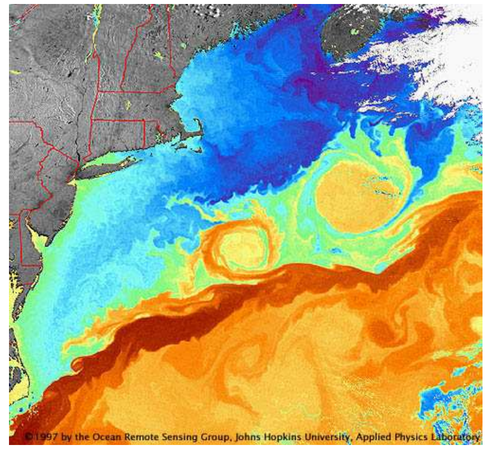


Introduction

It has been well-established that phytoplankton in the ocean's upper layer binds carbon dioxide from the atmosphere and hence reduces the greenhouse effect [1]. By transporting nutrients and plankton itself, turbulent 'stirring' of the ocean is thought to have a large influence on plankton growth and dispersal patterns [2]. Unfortunately, this influence is not yet quantified or even well understood. Hence, our aim is to investigate and quantify the impact of ocean eddies on plankton growth and dispersal by means of computer simulations.

Coupled model

The model consists of:

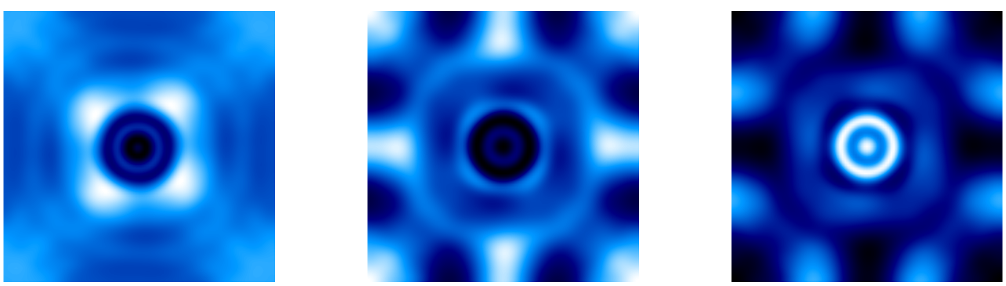
- a nonhydrostatic flow model (described by Molemaker and Dijkstra [3])
- a two-reserve two-nutrient mixotroph plankton model [4] based on the Dynamic Energy Budget theory [5]

Preliminary results

In our first simulations, we modeled plankton growth in a simple eddy with associated vertical transports caused by baroclinic instability of the flow [3]. The main results of the vertical 'stirring' induced by the eddy are:

- a slightly higher plankton concentration than without the eddy
- low plankton and high nutrient concentrations in regions with upwelling and vice versa in downwelling regions

Dispersal of the plankton and the nutrients by the horizontal flow and a phase delay of the nutrients and biomass with respect to the vertical flow lead to slight differences between the upwelling and the plankton/nutrient distribution patterns.



Horizontal cross-section of the simulated vertical velocity field (left), the nutrient concentration (middle) and the biomass concentration (right); dark colours signify downwelling/low concentrations, light colours signify upwelling/high concentrations. Although production rates are highest in regions with high nutrient concentrations, actual biomass concentrations are low in these regions because of mass conservation.

References

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[4] Kooijman et al., Light-induced mass turnover in a mono-species community of mixotrophs, J. Theor. Biol. 214: 233–254 (2002)

[5] Kooijman, Dynamic energy and mass budgets in biological systems, 2nd edition (2000)

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